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INNOVATION

Mission Takes Control

Satellite to See Through Clouds

Robotic Aircraft Used in Study

Innovative Cyrogenic Equipment More Efficient

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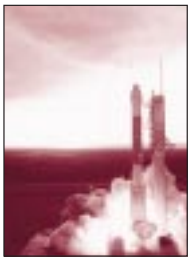
Contents



About the Cover:
Launched by Delta II rocket on October 24, 1998, Deep Space 1 is the first spacecraft to actually use ion propulsion to reach another planetary body.

On-Line Edition: Go to **http://nctn.hq.nasa.gov** on the World Wide Web for current and past issues.

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COMMERCIAL DEVELOPMENT MISSION UPDATE

Date*	Flight	Payload	Sponsor/Coordinator
7/99	STS-93	AEROGEL	Marshall Space Flight Center
	AXAF	Commercial Generic Bioprocessing Apparatus-04**	BioServe Space Technologies

* As of June 1999.
** In combination with National Institutes of Health payload NIH-B1 in support of Life Sciences Division requirements.
Key STS—Space Transportation System, AXAF—Advanced X-ray Astrophysics Facility (renamed Chandra X-ray Observatory)

Deep Space 1 and the New Millennium Program

by Marc D. Rayman, Ph.D.
Deep Space 1 Deputy Mission Manager and Chief Mission Engineer, Jet Propulsion Laboratory

SCIENCE FICTION AND SPACE ENTHUSIASTS, as well as space scientists, have long dreamed of having routine access to space to rapidly face the unexpected and investigate the universe. NASA has rocketed toward that reality with October 1998's launch of Deep Space 1 (DS1), the first mission of NASA's New Millennium Program (NMP).

Space science missions' astonishing and impressive discoveries have often been at great expense. NASA and the United States cannot afford to conduct space exploration the way it has been done in recent decades, yet we now look forward to a future of launching into deep space every month instead of every year or so.

How do we meet the challenges of such a future? We need to learn to build spacecraft quickly, to make them small enough to be launched on inexpensive rockets and to implement them fast enough to reach their destinations while the questions they are addressing are still relevant. The spacecraft must also be sufficiently sophisticated to collect the exciting information we seek, and smart enough to handle unexpected situations without all of them tying up the precious and expensive Deep Space Network.

Part of the answer is to introduce advanced technologies. Unfortunately, that means risk. There will always be a lingering uncertainty over whether the new systems will work in space the way we predict. As a result, revolutionary technologies often have inordinate waits before finding their way aboard space missions.

NASA's NMP is chartered to validate the selected high-risk technologies needed to make future space exploration less expensive, yet even more exciting and productive. Throughout DS1's flight, the technology payload has been rigorously exercised so that later space missions will be able to use the new capabilities with confidence. This bold mission took risks so that future missions will not have to. Technologies that were considered very risky when DS1 launched are now proven and available to designers who need these new capabilities but cannot afford to take high risks.

DS1 included a computer software experiment, Remote Agent, one of 12 technologies validated during the flight. The experiment contained artificial intelligence that allowed it to "think" for itself to generate procedures for executing mission goals. Future spacecraft may rely on this type of software to handle a wider range of unexpected situations on their own.

Even if a technology had failed on this ambitious flight, we still would have been able to help prevent later missions from taking too much risk. In the relatively brief 39 months between conception and launch, we have solved problems that would never have been addressed if the new technologies were still on paper or in the laboratory. This work had already contributed to the technologies' use in future missions, even before launch. Now, with the remarkable successes of these systems in flight, many missions that would have been impossible or unaffordable can be undertaken.

NMP develops, and its missions test in space, futuristic technologies that will make spacecraft "smarter" and help reduce the size and mass of future spacecraft, showing how much savings these advanced technologies will bring in the future. Ion propulsion will permit faster access to important destinations in the solar system. Autonomy will reduce the cost of operating such missions. Miniaturized systems will make spacecraft smaller and less expensive. New, highly capable instruments will make sophisticated measurements with small packages.

By taking risks with DS1 and subsequent NMP missions to validate revolutionary technologies, NASA is preparing for when humankind's robotic (and, eventually, human) emissaries to space are routinely reporting back inspiring discoveries from throughout the solar system and beyond.

Industry and academia are closely involved in all key areas of NMP. Six integrated product development teams (more than 50 companies), research laboratories and universities are actively helping identify and develop new technologies and instruments with the potential to revolutionize space exploration. Created in 1994, NMP forms partnerships among organizations in government, private industry, academia and the nonprofit sector so that the expertise and know-how of scientists, engineers and managers can be pooled as a resource to meet the program's goals.

American taxpayers should feel proud of their investment in this program. NASA receives only a small fraction of U.S. tax dollars and is committed to spending that money wisely, trying to get the maximum benefit from each dollar invested.

Mission Takes Control

IT IS "ONE SMALL STEP" IN THE HISTORY OF robotic space flight, but it may turn out to be "one giant leap" for computer-kind. Artificial intelligence software took primary command of a spacecraft for the first time during the days of May 17, 18 and 21.

NASA's "faster, better, cheaper" paradigm is not an objective of the New Millennium Program (NMP), but Deep Space 1 (DS1), NMP's first mission, has indicated the paradigm may be an underlying benefit from NMP. Since its October 1998 launch, DS1 nearly finished validating 12 new technologies, including artificial intelligence software known as Remote Agent. This mission is one of the first-ever deep space NASA launches to have technology, rather than science, as its key focus.

"Science mission project managers are reluctant to take the risk of using untested technologies," said Dr. Wesley Huntress, who was NASA's Associate Administrator for Space Science during the creation and development of DS1. "The New Millennium Program is devoted to testing out new technologies first so they can be used with greater confidence on upcoming faster, better, cheaper scientific missions of the early 21st century."

Tests also are being conducted on advanced technologies designed to make spacecraft smaller, less expensive and capable of more independent decision-making so that they rely less on tracking and intervention by ground controllers. DS1 has been guided most of the time by its autonomous navigation system. Additional testing remains for another of the autonomy technologies, and a final navigation system test is scheduled during an encounter with asteroid 1992 KD in late July.

A Boeing Delta II (7326) rocket propels Deep Space 1 to space. Onboard experiments include software programmed to allow the spacecraft to make its own navigation decisions without the intervention of ground controllers.

The artificial intelligence experiment that primarily commanded DS1 for periods of time during three days in May is known as Remote Agent. The experiment's software was programmed to diagnose the cause of simulated problems, take corrective action and then monitor its performance. If there are last minute changes in the plan of the spacecraft, instead of having to scrap the whole program, the alterations are made on board.

On the first day, Remote Agent successfully controlled the spacecraft and its futuristic ion engine for nearly the entire day, while it resolved a simulated instrument failure. Then, the ground team detected an anomaly—the component that issues commands had suspended operation and Remote Agent did not command the spacecraft's ion propulsion system to shut down as expected. An easily correctable bug was identified, thus illustrating the value of testing on an operational spacecraft. A new experiment was designed to achieve the remaining objectives three days later.

This unique software was a collaborative development between Ames Research Center and the Jet Propulsion Laboratory (JPL). DS1, part of the New Millennium Program, is managed by JPL for the Office of Space Science at NASA Headquarters.

Decreasing Costs

Space missions can be time consuming and expensive. Remote Agent and DS1's other advanced technologies have the potential to contribute to decreased costs, thereby increasing the number of missions that can be conducted and the amount of knowledge that can be gained with a fixed budget.

Part of the high cost of space exploration is the cost of operating the Deep Space Network (DSN). If a mission is run by ground control, it must have frequent communication with Mission Control via the DSN. Remote Agent makes the spacecraft autonomous in that it can generate and execute its own plans, and then correct many failures without communicating with ground control. By cutting down on the amount of communication a spacecraft must have with Earth, the cost of the mission is decreased.

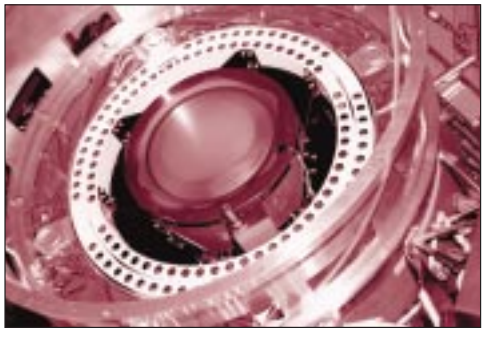
Equipment Sharing Saves Costs for DS1 and Mars Missions

An increasing trend in NASA's current era of "faster, better, cheaper" missions is for space missions to benefit and borrow from technologies flown on recent predecessors. DS1 has taken full advantage of this opportunity by purchasing spare hardware from Mars Pathfinder and other missions.

From antennas and headsets to computers and cables, there are many technology links between these missions. Although these are not advanced technologies in the way that DS1's 12 technologies are, this synergy between missions has helped boost reliability and save costs.

Some of the new technologies tested on DS1 are:

- **Solar Electric Propulsion—**This uses electricity and atoms to push the spacecraft through space. Ion engines accelerate over long times, giving each ion a tremendous burst of speed. The DS1 engine provides about 10 times the specific impulse (ratio of thrust to propellant used) of chemical propulsion.
- **Solar Concentrator Arrays—**These solar arrays are less expensive and more resistant to radiation than conventional arrays.
- **Autonomous Navigation—**This allows DS1 to correct its course as it flies, using images of asteroids and stars collected by the onboard camera system, without needing help from ground control.
- **Miniature Integrated Camera and Imaging Spectrometer—**This combines several kinds of picture-taking devices into one low-mass system. The camera-imaging spectrometer package is about 10 times less in mass, cost and power consumption than conventional instruments that perform similar functions.
- **Miniature Integrated Ion and Electron Spectrometer—**Several different measurement capabilities are integrated into one compact instrument that is one-quarter the size of currently used comparable instruments and requires less than half of the power of conventional instruments. This scientific instrument will help monitor possible incompatibilities of using the ion propulsion engine by measuring the energy spectrum of electrons and ions. It electrostatically sweeps its field of view with high-mass resolution, instead of using moving parts.
- **Telecommunications Devices—**New low-mass communications devices include a miniaturized 3.2-kilogram transponder and a high-frequency, solid-state amplifier that amplifies the transponder radio signal. Ka-band, the newest frequency being considered for deep space communications, is four times higher than the currently used X-band. A system with similar capability using current technology would be more than twice as heavy and cost three times as much.
- **Beacon Monitor Operations—**This technology sends one of four signals about spacecraft health to small receivers on Earth. Therefore, costly DSN time does not need to be used to get spacecraft health information, thus reducing the need for constant monitoring by mission controllers.
- **Microelectronics and Spacecraft Structure—**Sophisticated ultraminiaturized electronics that consume less power, and a multifunctional structure that integrates electronics with the spacecraft, demonstrate futuristic technologies for making the spacecraft smaller, lighter and more efficient.



Deep Space 1's solar-powered ion engine is the first nonchemical propulsion to be used as the primary means of propelling a spacecraft.

The first flight in NASA's New Millennium Program, Deep Space 1 is designed to validate 12 new technologies for scientific space missions of the next century.

More explanation of each technology is at *http://nmp.jpl.nasa.gov/ds1/tech/advtech.html*

For more information, contact David H. Lehman at Jet Propulsion Laboratory. 818/354-2023, 818/393-4277, *David.H.Lehman@jpl.nasa.gov*

Please mention you read about it in *Innovation.*

NASA License Improves Helicopter Performance

A WASHINGTON STATE COMPANY WORKING with Langley Research Center in Hampton, Virginia, has licensed NASA technology for improving the performance, stability and control of helicopters. The company, Boundary Layer Research, Inc. (BLRI), of Everett, Washington, will commercially market an aerodynamic device called "tailboom strakes."

The license will allow BLRI to market the NASA-patented device to civil and military operators of single-rotor helicopters. The company has applied for Federal Aviation Administration certification to make the technology available to civil operators and owners.

Developed by a NASA-Army team of researchers, the helicopter strake technology is applicable to all single-rotor helicopters. It is patented by NASA as a "Low Speed Anti-Torque System."

BLRI has been exploring a variety of technology benefits. These include improved stability, less horsepower needed for the tail rotor, improved yaw (side-to-side) control, improved altitude performance, increased payload capability at altitude, reduced fatigue for tailboom and related flight critical components, and reduced maintenance costs.

The upper and lower tailboom strakes run the entire length of the tailboom on the port side only. The strakes are typically 10 to 15 feet long and extend diagonally from the surface about three inches, one near the top of the tailboom and one near the bottom. At slow airspeeds, these narrow surfaces provide resistance to the air coming down from the main overhead rotor, creating a high-pressure area on the tailboom's port side. This significantly counteracts a single-rotor helicopter's natural tendency to turn because of torque, improving the pilot's control over the helicopter.

UH-1H helicopters continue to be outfitted and evaluated with a commercialized NASA technology to improve pilot control over the helicopter.

BLRI President Robert Desroche said, "We are very pleased to be selected by NASA to further develop this technology and are anxious to get it to the operators where it can do some good. Operators work a very delicate profit margin, and this technology will help tip the scale in their favor since it can reduce maintenance costs and increase performance. The fact that it improves safety by improving yaw control margins is just icing on the cake."

The company recently shipped a set of helicopter strakes to the U.S. Army Flight Test Evaluation Center at Ft. Rucker, Alabama, to be evaluated for the Army's fleet of single-rotor helicopters. In the past few months, the Royal New Zealand Air Force and the Australian Defence Force have each outfitted UH-1H helicopters with strakes after learning of the technology from Army researchers at NASA and conducting their own evaluations with close collaboration from NASA.

BLRI designs and develops products that enhance performance of personal and business aircraft. The device represents the company's first venture into the rotorcraft modification market. Recently, the company announced a reorganization and the hiring of key staff to facilitate the anticipated growth of the new Rotary Wing Division.

For more information, contact Henry Kelley at Langley Research Center. 757/566-0321, *hkelley@widomaker.com* Please mention you read about it in *Innovation.*

NASA Dual-Use Technology Marketed

UNDER A DUAL-USE AGREEMENT WITH NASA'S Kennedy Space Center in Florida, an Alabama company is marketing the TESA 2000 Portable Inspection Instrument used for surface optical measurement in processing the Space Shuttle and its payloads. NASA selected AZ Technology, Inc., of Huntsville to jointly develop a portable infrared and solar reflectometer to meet both NASA and commercial applications.

The TESA 2000 represents substantial innovation and considerable advancement in laboratory portable instrumentation for determining ambient temperature, total emittance and solar absorptance of test surfaces. It is compact, lightweight, rugged and ergonomically engineered for ease of use in the field or in the laboratory, AZ spokesperson John Harchanko said.

The instrument costs about $70,000. It comes with two carrying cases, two rechargeable batteries, a battery charger, an instrument inspection head, a display unit and an operator vest. It offers internal, nonvolatile storage of up to 800 field measurements, as well as multiple-scan storage convenience in the laboratory. Kennedy Space Center expects the TESA 2000 to bring 50 percent savings in surface inspection costs.

The TESA 2000 is a proven benefit to space applications. For example, it will benefit NASA's Space Shuttle fleet and its payloads; manufacturers, servicers and users of manned space vehicles; manned stations and spacecraft for telecommunications, science, meteorology, navigation, remote sensing and imaging.

This innovation will benefit multiple users in manufacturing, science and the military, in addition to serving the needs of NASA. The TESA 2000 can be used by companies involved with the military, paints/coatings, solar energy and automotive glass.

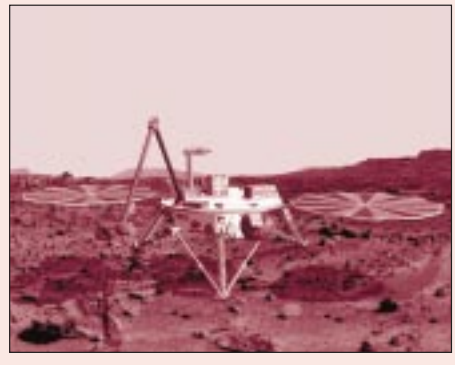
The military could use the technology for evaluating low observable coatings for land, sea and air vehicles. Commercial coating manufacturers and testing laboratories could use the technology to measure surface properties of coating panels in environmental tests for weathering. Companies involved with solar cells or solar heating systems could use the technology to evaluate efficiency. Automotive glass manufacturers and testing laboratories could use the TESA 2000 to evaluate windshields and coatings for Department of Transportation reflectance standards.

A dual-use agreement produced this TESA 2000 portable version with benchtop strength of the 1960s solar absorptance and emittance apparatus.

AZ Technology is a technology services company specializing in scientific and engineering research and instrumentation development. The company has particular expertise in space flight experiment development,

SIMULATED MARS ENVIRONMENT PROVIDES ESSENTIALS

Scientists at NASA's Johnson Space Center in Houston, Texas, recently demonstrated a technology that could use the Martian environment to produce oxygen for breathing and propellants, as well as be used to extract pure oxygen from Earth's air for home, medical and military needs. The demonstration served as an initial test of technology that will be aboard the Mars Surveyor 2001 Lander, scheduled to launch in 2001 and land on Mars in 2002. The Lander is expected to provide essential insights into how to conduct successful, cost-effective human missions to Mars. Its primary science goal is to explore the mineralogy of its landing site.



Technology that will be aboard the Mars Surveyor 2001 Lander could produce oxygen from elements of the Martian environment. It could also be used for oxygen extractions on Earth.

The test involved the Mars In-Situ Propellant Production Precursor, an experimental device, inside a chamber that simulates Martian temperatures and atmospheric pressures. A solid-oxide zirconia ceramic disk is heated to 1,380 degrees Fahrenheit (750 degrees Centigrade). Carbon dioxide is absorbed on one side of platinum electrodes and converts to oxygen. Only oxygen is allowed to penetrate to the other side.

"The concept is to use the resources on Mars to reduce the amount of material that needs to accompany a human mission to 'live off the land' while on Mars," said Principal Investigator David Kaplan of the Exploration Office at Johnson Space Center. "Producing oxygen using materials readily available on Mars would be an important step toward reducing the costs and risks of an eventual human mission to Mars."

Johnson Space Center is NASA's lead center for the Human Exploration and Development of Space (HEDS) Enterprise. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, California, manages the Mars exploration program.

For more information, contact Kelly Humphries at Johnson Space Center. 281/483-5111, *Kelly.O.Humphries@jsc.nasa.gov* Or contact Mary Harden at the Jet Propulsion Laboratory. 818/354-0344, *Mary.hardin@jpl.nasa.gov* To view photos, visit *http://mars.jpl.nasa.gov/2001/* Please mention you read about it in *Innovation.*

production instruments for scientific measurements, advanced materials and coatings, and Internet software for space and commercial applications.

Two other AZ Technology instruments, the Optical Properties Monitor (OPM) and the Space Portable SpectroReflectometer (SPSR), have flown on the Space Shuttle and Russia's *Mir* space station. Future projects are in the works for the International Space Station.

For more information, contact Lewis Parrish at Kennedy Space Center. 407/867-6373, *ParriLM@kscgws00.ksc.nasa.gov* Or contact John Harchanko at AZ Technology, Inc. 256/837-9877, ext. 143, *johnh@aztechnology.com* Please mention you read about it in *Innovation.*

Licensed Technology Increases Laser Use, Reliability

NASA'S LANGLEY RESEARCH CENTER IN Hampton, Virginia, has licensed a remote-sensing technology to a Montana company for the protection of commercial laser systems. This could result in significant potential savings for the customer and increased reliability of lasers in areas ranging from the medical industry to product fabrication and gas leak detection.

The NASA agreement allows Big Sky Laser Technologies, Inc., of Bozeman, Montana, to offer customers a new level of protection against the potential problem of undesired prelasing. Optical components can be damaged and have significant downtime for repair when uncontrolled laser energy prematurely leaks from a laser cavity, sometimes caused by unexpected reflections from the target back into the device.

Licensing laser protection circuitry technology is expected to provide more reliable real-world laser services, resulting in significant cost savings.

The NASA laser protection circuit can detect such prelasing and terminate operation before damage to the laser occurs. The circuit can prevent the buildup of laser pulse energy to self-destructive levels.

Big Sky Laser has already begun modifying an existing line of miniaturized lasers with the technology. The laser, called the CFR 800, is able to perform in real-world applications because it is compact and rugged and offers turnkey operation. "With laser heads up to 90 percent smaller and 75 percent lighter than scientific lasers, the CFR series allows users to take lasers where they could not go before," said Big Sky Laser President Ed Teppo.

Applications of Langley's circuit protection technology and laser miniaturization can make lasers more adaptable for monitoring pollution and tracking their sources and for detecting methane and other hazardous gas leaks. The technology can be used in the offices of dermatologists, medical doctors and plastic surgeons, in factories for fabrication, marking and laser cleaning and in other applications not yet defined.

The company's high-powered CFR 800 laser, one-eighth the size of comparable laser systems, has been marketed for a wide range of applications, including LIDAR, remote sensing, eye-safe illumination, ablation, laser marking and laser splitting of molecules for the observation of light emission (laser-induced breakdown spectroscopy). The CFR 800 delivers 800 milliJoules energy per pulse at 1,064 nanometers, with a peak intensity millions of times brighter than a common light bulb.

The MSU TechLink Center, a technology transfer and commercialization partnership between NASA and Montana State University, continues to facilitate and assist Big Sky Laser in the technology's commercial development and application into other company products.

Big Sky Laser is a provider of laser damage testing services and an ISO 9001-certified developer of compact, rugged, commercial and developmental turnkey laser systems that have been used by NASA to track Space Shuttle and rocket launches. The company's laser systems are being used in medicine, ranging, imaging, artwork restoration, laser cleaning, remote sensing, environmental sciences, process control and spectroscopy.

For more information, contact Sherry Sullivan at Langley Research Center. 757/864-2556, *s.l.sullivan@larc.nasa.gov* Or contact Ray Friesenhahn at MSU TechLink Center. 406/994-7726, *rayf@montana.edu* Please mention you read about it in *Innovation.*

Satellite to See Through Clouds

NASA WILL TAKE A REVOLUTIONARY, GLOBAL look at clouds with a new spaceborne radar capable of peering deep into their interior to study their structure, composition and effects on climate. Cloudsat, which will fly in 2003, will use an advanced radar to "slice" through clouds to see their vertical structure, providing a completely new observational capability from space.

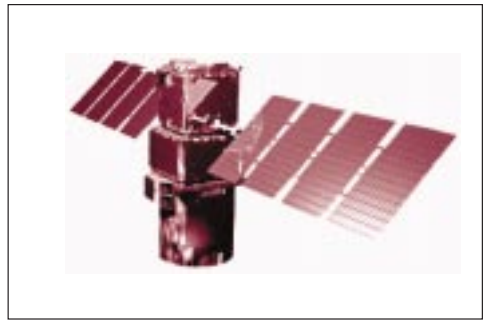
Current weather satellites can only image the uppermost layers of clouds. Cloudsat will be the first satellite to study clouds on a global basis.

"A trio of satellites will provide unprecedented information on how clouds help transfer solar energy to and from our planet's atmosphere," said Dr. Ghassem Asrar, Associate Administrator for Earth Science at NASA Headquarters in Washington, D.C. "The data from Cloudsat will help us understand changes in the Earth's climate on global, regional and local scales. An important contribution of Cloudsat is the way it will fly in formation with the Earth Observing System-PM and the PICASSO-CENA satellites."

PICASSO-CENA, a cooperative mission between NASA and France, will study the role of transparent, thin clouds and aerosols, small atmospheric particles and their effect on solar-energy transfer. The Cloud Profiling Radar of Cloudsat will study the three-dimensional structure of most clouds important to weather and climate. This capability complements an instrument aboard PICASSO-CENA, which will observe the vertical structure of thin clouds and aerosols. These two missions will provide critically needed satellite measurements that will help researchers understand how Earth's solar energy and climate interact on a global scale.

Cloudsat data also will complement the Earth Observing System-PM (EOS-PM) satellite, which will collect data on the dynamics of Earth's atmosphere, as well as the Triana mission. Both are scheduled to be launched in 2000.

Dr. Graeme Stephens of Colorado State University, Ft. Collins, Colorado, will be the Principal Investigator of the Cloudsat mission. NASA's Jet Propulsion Laboratory in Pasadena, California, will manage the international mission, which will include participation from the United States, Canada, Germany and Japan.

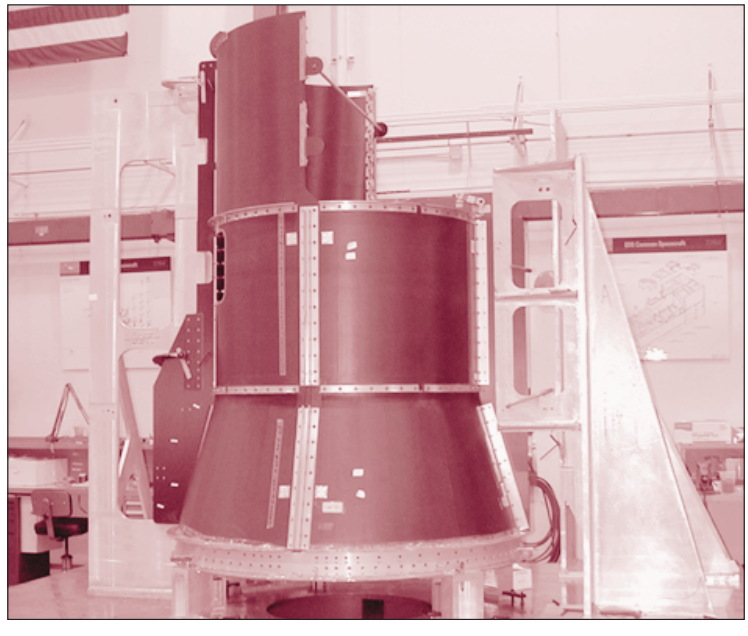


One satellite to fly with Cloudsat as part of a global study is PICASSO-CENA, a cooperative mission between NASA and France. Unlike current satellites, Cloudsat will image a cloud's interior.

The Canadian Space Agency also is developing key radar components and contributing scientific expertise. Ball Aerospace of Boulder, Colorado, will build the Cloudsat spacecraft.

The Cloudsat mission is committed to Earth systems science. This area is undertaken by NASA's Office of Earth Science, which oversees a long-term, coordinated research enterprise designed to study Earth as a global environmental system.

For more information, contact David E. Steitz at NASA Headquarters. 202/358-1730, 202/358-4210, *dsteitz@hq.nasa.gov* Please mention you read about it in *Innovation.*



Another satellite to fly with Cloudsat is EOS-PM.

Inventions of the Year Selected

A LANGLEY RESEARCH CENTER TECHNOLogy, now commercially available with $10 million in sales, has been selected as the NASA Commercial Invention of the Year. The NASA selection committee also chose a Goddard Space Flight Center inventor for the Government Inventor of the Year Award.

PETI-5, short for "Phenylethynyl Terminated Imide Oligomers," fifth composition, is a high-temperature resin material originally developed for high-speed, high-temperature aircraft applications because it is strong and lightweight. With an exceptional properties combination, this material can be used both as a glue that holds fibers together and as an adhesive in a variety of aerospace and commercial applications. Langley inventors Paul Hergenrother, Joseph Smith and Brian Jensen were awarded three patents on the novel material.

To date, NASA has licensed PETI-5 technology to four companies. Designers and manufacturers are very satisfied with PETI-5 because it is easy to process into complex parts and because of its mechanical properties, durability, nontoxicity and ability to adjust to changing environments. In the future, PETI-5 may be applied to such consumer products as high-performance automobile engines.

IN THE FUTURE, PETI-5 MAY BE APPLIED TO SUCH CONSUMER PRODUCTS AS HIGH-PERFORMANCE AUTOMOBILE ENGINES.

The NASA Government Inventor of the Year Award goes to Goddard employee/inventor Charles E. Clagett for his device that helps stabilize NASA

RESEARCH BREAKTHROUGHS IN RADIATION PROTECTION

An evaluation of microorganism contamination safeguards for an upcoming Mars mission has resulted in the discovery of a novel compound that may lead to breakthrough methods for protecting astronauts and sensitive electronic equipment from space radiation's harmful effects. Montana Biotech Corporation of Belgrade, Montana, has just signed a Technology Cooperation Agreement with NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, for research on radiation shielding compounds. The MSU TechLink Center, a technology transfer and commercialization partnership between NASA and Montana State University (MSU) located in Bozeman, Montana, helped broker the agreement.

The agreement stems from a recently completed project between Montana Biotech and Johnson Space Center to improve methodologies for recognizing and analyzing microorganisms in rock samples acquired during NASA space missions. MSU Associate Professor Dr. David Singel assisted Montana Biotech in testing the compound's radiation protection effects. The new agreement calls for measuring this new compound's ability to shield gamma radiation, the relative effectiveness of different formulations of the compound and its ability to shield other types of radiation, including x-rays and proton and electron radiation. Preliminary results indicate that the compound can shield other organisms, fiber optics and microcircuits from radiation's harmful effects. The implications of this research extend into the areas of satellite communications, bioremediation and nuclear medicine.

Montana Biotech specializes in analyzing and isolating unique compounds from microorganisms found living in extreme environments, such as boiling, acidic or radioactive water, and developing commercial products from these compounds. Examples of products include environmentally friendly adhesives, anti-oxidants and antifungals for the biomedical market and environmental remediation agents.

For more information, contact Will Swearingen at MSU TechLink Center. 406/994-7704, *wds@montana.edu* Please mention you read about it in *Innovation.*

spacecraft, called the "Apparatus for Providing Torque and for Storing Momentum Energy." Clagett is Associate Head of the Component and Hardware Systems Branch at Goddard in Greenbelt, Maryland.

"Being selected the NASA Government Inventor of the Year is really a surprise, an honor and quite a shock," said Clagett. "I appreciate the fact that I have been recognized for my invention."

Commonly known as the SMEX Reaction/Momentum Wheel, Clagett's device was developed for NASA's Small Explorer program (SMEX). A compact mechanism that could accelerate at a high rate with little vibration was needed to fulfill the missions' science requirements. The wheel's compact design is durable, with at least a four-year life expectancy, while providing improved performance and better stability for a spacecraft, as well as significantly reducing vibration.

This reaction wheel invention has been highly successful on the last two Small Explorer missions, the Transition Region and Coronal Explorer and the Submillimeter Wave Astronomy Satellite. The high-acceleration-rate and low-vibration device allows for the detection of signals that would have been obscured by previous reaction wheels, thus enabling Goddard to support missions that previous technology could not support.

The inventors will be honored at a NASA Headquarters ceremony, where they will receive an award check and certificate.

For more information, contact Sonja Alexander at NASA Headquarters. 202/358-1761, *salexand@hq.nasa.gov* Or contact Keith Henry at Langley Research Center. 757/864-6120, *h.k.henry@larc.nasa.gov* Please mention you read about it in *Innovation.*

Proposals for Advanced Radar Technology

NASA IS REVIEWING PROPOSALS SOUGHT FOR a low-cost, advanced imaging radar technology that will reduce the cost and enhance the performance of Earth-observing satellites. This in turn will open new opportunities for the U.S. commercial remote-sensing industry.

The Lightweight Synthetic Aperture mission, or "LightSAR," is part of NASA's long-term effort in the development and productive use of imaging radars. Past NASA radar missions, which have been short in duration, have established the potential of imaging radar to expand scientific knowledge of Earth and the planets.

The satellite's capability to observe Earth, day and night, in all weather, is expected to result in numerous scientifically valuable and commercially lucrative applications. For example, LightSAR will have the unique capability to continuously monitor minute changes in Earth's surface, down to the one-millimeter level, which will lead to improved understanding of natural hazards, such as earthquakes and volcanoes.

The satellite's advanced capabilities also will greatly help improve governments' emergency management efforts and may prove useful to industries involved in disaster recovery. Other applications of the satellite will include observing the movements and changing size of glaciers and ice floes as part of long-term Earth climate studies. Forest regrowth and global vegetation maps produced by LightSAR will support NASA's ongoing studies of Earth's environment.

LightSAR's high-resolution imaging capability has significant commercial potential for mapping Earth's surface, environmental surveillance, crop monitoring, land management, planning and development. One of the unique features of this NASA program will be to encourage proposers to share the costs of developing and deploying the satellite's capabilities in return for commercial rights to data.

Proposals for mission development and operations using LightSAR have been sought from many organizations, including educational institutions, industry, nonprofit institutions, NASA field centers, federally funded research and development centers and other government agencies.

NASA's Jet Propulsion Laboratory in Pasadena, California, is managing the LightSAR project for NASA's Office of Earth Science in Washington, D.C., which oversees a long-term, coordinated research enterprise designed to study Earth as a global environmental system.

For more information, contact David Steitz at NASA Headquarters. 202/358-1730, 202/358-4210, *dsteitz@hq.nasa.gov* Please mention you read about it in *Innovation.*

Robotic Aircraft Used in Study

CHARACTERISTICS OF HIGH-LEVEL CIRRUS clouds that may affect global warming were measured over the subtropical Pacific for the first time in late April and continued through mid-May to help better understand climate changes and to build more accurate global climate models. Data from the study will help scientists better understand the dual roles of clouds—reflecting and absorbing solar energy—that are key uncertainties of global climate models used to predict climate change.

The measurements will help develop a global picture of how solar energy enters the atmosphere and moves within and through clouds. Clouds are effective at both reflecting incoming solar energy back to space and absorbing warm longwave radiation from Earth's surface, keeping that heat in the atmosphere, according to Dr. Peter Pilewskie, a Principal Investigator at NASA's Ames Research Center, Moffett Field, California.

Under a jointly funded Department of Energy-NASA atmospheric research project, data were gathered using specially designed instruments carried by a remotely piloted aircraft called Altus, flying at an altitude of 50,000 feet off the Hawaiian island of Kauai. The aircraft carried a 340-pound payload of radiometers, laser-based lidar detection devices and similar instruments to collect and transmit information about clouds.

This remotely piloted aircraft carried data that, for the first time ever, successfully measured cirrus clouds for clarity and accuracy in understanding climate changes and building models.

A second aircraft, a DHC-6 Twin Otter, flies beneath the clouds in stacked formation with the Altus above, carrying radar from NASA that probes the ice and water content of the clouds. The remaining flights were carried out under a variety of conditions, with the unoccupied Altus controlled by pilots on the ground.

The Altus aircraft was built for NASA by General Atomics Aeronautical Systems, Inc. NASA's Dryden Flight Research Center, Edwards, California, provided the aircraft and is funding the flight series at the U.S. Navy's Pacific Missile Range facility. The climate studies are being guided by the Sandia National Laboratories for the Department of Energy's Atmospheric Radiation Measurement–Unmanned Aerospace Vehicle program.

The current series of flights by the Altus demonstrates the scientific and commercial potential of the remotely operated aircraft NASA is developing, according to Dr. James Stewart, manager of NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program at Dryden. This study marks the first time scientists have been able to get measurements from cirrus clouds with these instruments, according to Stewart, and may be the most successful flights that Sandia has flown while recording good atmospheric radiation data at these altitudes.

In the future, climate researchers would like to conduct similar measurements in a deep tropical region, closer to the equator, where tropical storms are responsible for bringing much moisture from the ocean into the atmosphere in a process that drives the dynamics of weather patterns far and wide. Once the dynamics are better understood, the climate models can reflect that understanding and improve forecasting.

Roughly 25 researchers from three Department of Energy laboratories, a dozen universities, three NASA centers and four private companies worked together at the Navy facility during the four-week mission. More information on the experiment is available at *http://armuav.atmos.colostate.edu/uavs99/uavs99.html*

For more information, contact Fred Brown at Dryden Flight Research Center. 805/258-2663, *Fred.Brown@dfrc.nasa.gov* Please mention you read about it in *Innovation.*

X-34 Rolled Out for Testing

THE FIRST OF THREE X-34 VEHICLES expected to prove technologies that could revolutionize space travel, making it as spontaneous as today's air travel, was unveiled in late April at Dryden Flight Research Center. The X-34 is part of NASA's efforts to demonstrate that properly designed rocket vehicles can be easy and inexpensive to operate.

Considered a technology demonstrator, the gray, white and black single-engine rocket plane will begin proving new composite material structures, a new engine and a thermal protection system that could help a future spacecraft get to orbit more economically than current space vehicles. Eventually, an X-34 vehicle could greatly reduce the costs for getting to space and lead to new business opportunities. If the X-34 proves its groundbreaking technologies, NASA officials hope it will eliminate some of the risks for commercial space launch systems.

"By reducing the cost of launch services, space will be made more accessible to a wider group of commercial and government customers," said David W. Thompson, Orbital Science Corporation President and Chief Executive Officer. Orbital, which is based in Dulles, Virginia, is designing, developing and testing the vehicle. "With reduced launch costs, government budgets could support more frequent scientific or national security missions, and commercial users that provide services from satellites, such as voice and data communications or Earth imagery, could lower prices for their customers," Thompson said.

The navigation system for the X-34 is built by the same company contracted to build a navigation system for the X-33 Advanced Technology Demonstrator. This system is one example of X-34 components and testing that can help build confidence in components that will be used on the X-33 when it flies from Edwards Air Force Base in 2000, said Gary Payton, NASA's Deputy Associate Administrator for the Office of Aero-Space Technology.

The remotely piloted aircraft will fly with onboard computers and is about 58 feet long, 27 feet wide and 11 feet tall. It will launch from an L-1011 airliner, from which it will obtain altitudes of up to 250,000 feet and travel up to Mach 8. The X-34 test flight will start when the aircraft releases the X-34 and then the X-34 engine will fire.

The first tests will be unpowered approach and landing tests to verify the aircraft's aerodynamic shape. The

Shown in this artist's rendition, the X-34 is expected to provide travel to space as easily as today's aircraft. The technology demonstrator was recently unveiled, with testing to follow.

X-34 will be able to fly through inclement weather, land horizontally at a designated landing site and safely abort during flight. Two flights in 24 hours and a two-week turnaround time by a crew of less than two dozen are envisioned for the first planned 27 test flights.

In addition to proving new technologies, such as autonomous landing, the X-34 also will serve as a technology testbed for at least nine other experiments at the conclusion of its initial flight tests. The first X-34 is an aerodynamic aircraft that may later be used for parts for the other two aircraft. The second and third X-34s will be capable of Mach 8 speeds.

Six NASA centers are involved in the X-34 project. Ames Research Center, Moffett Field, California, worked on the thermal protection system. Marshall Space Flight Center, Huntsville, Alabama, worked on the Fastrac engine and manages the X-34. Stennis Space Center in Mississippi tested the Fastrac engine. Langley Research Center, Hampton, Virginia, did wind tunnel testing, and Dryden completed vibration tests. Finally, Kennedy Space Center in Florida will demonstrate a 24-hour turnaround during flight tests.

For more information, contact Jay Levine at Dryden Flight Research Center. 661/258-3459, *jay.levine@dfrc.nasa.gov* Please mention you read about it in *Innovation.*

Safety Flight Control Software Tested

NASA IS TAKING ANOTHER STEP TOWARD its goal to reduce commercial aircraft accident rates by a factor of five over the next 10 years by being the first to apply experimental "neural network" software in a safety-related environment. The new "smart" software will enable pilots to control and

A finalist for a Discover Award, Transportation category, smart plane software tested aboard this modified F-15 is designed to "learn" how to fly a crippled airplane to help its pilots land it safely.

safely land disabled airplanes that have sustained combat damage or encountered major systems failures.

Neural network software has the ability to "learn" by observing patterns in the data it receives and processes, and then to perform different tasks in response to new patterns. The Intelligent Flight Control System (IFCS) employs experimental neural network software developed by computer scientists at NASA's Ames Research Center, Moffett Field, California, and the Boeing Company's Phantom Works division, St. Louis, Missouri.

Dryden Flight Research Center, Edwards, California, conducted flight evaluations of a preliminary version of the new "smart" software using a highly modified F-15 aircraft. The tests at Dryden demonstrated how the development version of the neural network software, pretrained to the F-15's aerodynamic data base and operating with a newly developed adaptive controller, can correctly identify aircraft stability and control characteristics. It then can immediately adjust the control system to maintain the best possible flight performance. About 16 flights were flown over a four-week period.

In its flight control application, the neural network software program compares the pattern of how the aircraft is actually flying with the pattern of how it should fly. These patterns are based on preprogrammed aeronautical equations, or control laws, that define how the airplane flies. If there is a mismatch caused by equipment failures, combat damage or other reasons, the aircraft's flight control computer uses the new neural network programming to "relearn" to fly the plane with a new pattern six times every second.

Using its on-line learning capability, the neural net software would identify that something has changed, then reconfigure the flight control computer system to adapt to those changes, making the failure or damage almost "transparent" to the pilot. To enable the pilot to maintain or regain control, it may change the way the remaining functional control surfaces and systems are used to compensate for the loss of the inoperative or damaged surfaces or equipment.

Future versions of the software could be developed for use in new airplanes that have digital fly-by-wire flight control systems, a requirement for the IFCS software. The system also has potential application to NASA's proposed Mars aircraft concept. These software versions will have even faster self-learning capability.

Proving that the neural network software works could lead to other uses, such as in power plants, automobiles and other less complicated systems to avoid potential disasters after equipment failures.

For more information, contact Chuck Jorgensen at Ames Research Center. 650/604-6725, 650/604-3594, *cjorgensen@mail.arc.nasa.gov* Or contact Mike Thomson at Dryden Flight Research Center. 661/258-3097, *Mike.Thomson@dfrc.nasa.gov* Or contact James M. Urnes, Sr., at Boeing Phantom Works. 314/234-3775, *james.m.urnes-sr@boeing.com* Please mention you read about it in *Innovation.*

SYNTHETIC VISION COULD PREVENT AVIATION ACCIDENTS

NASA and industry are developing revolutionary cockpit displays to give airplane crews clear views of their surroundings in bad weather and darkness, which could help prevent deadly aviation accidents. Limited visibility is the greatest factor in most fatal aircraft accidents, said Michael Lewis, director of the Aviation Safety Program at NASA's Langley Research Center in Hampton, Virginia. NASA has selected six industry teams to create Synthetic Vision, a virtual-reality display system for cockpits, offering pilots an electronic picture of what is outside their windows, no matter the weather or time of day.

"With Global Positioning Satellite signals, pilots now can know exactly where they are," said Lewis. "Add super-accurate terrain data bases and graphical displays and we can draw 3-D moving scenes that will show pilots exactly what's outside. The type of accidents that happen in poor visibility just don't happen when pilots can see the terrain hazards ahead."

The NASA Aviation Safety Program envisions a system that would use new and existing technologies to incorporate data into displays in aircraft cockpits. The displays would show hazardous terrain, air traffic, landing and approach patterns, runway surfaces and other obstacles that could affect an aircraft's flight. NASA has committed funds that will be matched by industry funds to advance Synthetic Vision projects over the next 18 months. More money is expected to be designated later to accelerate commercialization and make some systems available within four to six years.

The Aviation Safety Program is a partnership with the Federal Aviation Administration, aircraft manufacturers, airlines and the Department of Defense. Air traffic is expected to triple over the next 20 years. This partnership supports the U.S. government's goal to reduce the fatal aircraft accident rate by 80 percent in 10 years and by 90 percent over 25 years.

For more information, contact Kathy Barnstorff at Langley Research Center. 757/864-9886, *k.a.barnstorff@larc.nasa.gov* Please mention you read about it in *Innovation.*

Innovative Cryogenic Equipment More Efficient

A MICROGRAVITY EXPERIMENT THAT FLEW ON STS-95 in October 1998 has led to the development of a new cryogenic heat transport system with commercial and space applications in cooling electronics, sensors and fluids. Cullimore and Ring Technologies of Littleton, Colorado, and Swales and Associates of Beltsville, Maryland, developed the Cryo HTS through Small Business Innovation Research (SBIR) contracts from NASA's Goddard Space Flight Center. The Air Force Research Laboratory provided additional funding.

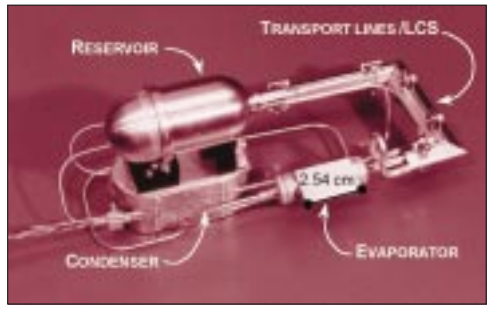
Operating without moving parts, the system uses a two-phase fluid Cryogenic Capillary Pumped Loop (CCPL), similar in concept to that found in a residential heat pump, to more efficiently transport energy at a fraction of the weight of highly conductive solid material such as copper. It isolates vibrations and operates in both ground and microgravity environments. The system removes heat from cryogenic components through evaporation and transports the resulting vapor to a cryocooler, where it is condensed.

Space cryocoolers are miniature refrigerators designed to cool sensitive spacecraft components to cryogenic temperatures below 100 degrees Kelvin (–280 degrees Fahrenheit). Cryogenic temperatures are necessary to operate many modern devices, such as infrared detectors and focal planes, solid-state gamma-ray detectors and a number of emerging superconducting technologies.

Space thermal control problems require a range of thermal control components. In certain types of spacecraft, such as those used in Earth-observing applications, infrared detectors and optics need to be very cold while co-existing with much warmer components. Many NASA near-term, future and advanced space instruments and programs depend on the successful use of long-life, low-vibration space cryocoolers to meet their scientific objectives.

When not operating, the CCPL provides excellent thermal isolation and can be used as an effective and low-cost cryogenic thermal switch. With inherent diode action, a CCPL-based thermal link can be turned on or off. This differs from routinely used flexible conductive links that, by definition, are always turned on.

The STS-95 experiment evaluated cryogenic thermal control components under the effects of a microgravity environment. The small size, low weight, high conductance, inherent flexibility and diode action of the Cryo HTS greatly facilitate the integration of multiple and all types of cryogenic components into a single cooling source for a component, as well as the ability to span joints requiring extreme flexibility.



A two-phase fluid loop similar to residential heat pumps transports heat.

An expansion of an extensive heritage of room temperature two-phase loops, the Cryo HTS offers performance benefits that are not currently within the reach of traditional cryogenic heat pipes and thermal switches. These efforts have demonstrated and matured the Cryo HTS technology, introducing a new, versatile and exciting integration option for the design of future cryogenic systems. The ultimate goal of any spacecraft thermal designer is to reliably solve complex spacecraft thermal design problems with minimal power, weight and cost output.

Other specific advantages with respect to cryocooler integration include fewer restrictions on test orientations than heat pipes, tighter temperature control at the heat source, and easier integration and greater conductance using components that can be integrally bonded. Potential spinoffs from this development include the miniaturization of room temperature devices and the extension to both colder (20 to 30 degrees Kelvin) and intermediate (100 to 200 degrees Kelvin) temperature regimes.

STS-95's testing of Cryo HTS was conducted under NASA's Hitchhiker project and developed and operated by Goddard's Small Payloads project. The Small Payloads project provides quick results and a low-cost way to send small payloads into orbit on the Space Shuttle for business and industry customers whose space activity requires power, data or command services.

For more information, please contact Jentung Ku at Goddard Space Flight Center. 301/286-3130, *jentung.ku@gsfc.nasa.gov* Or contact Jane Baumann or Brent Cullimore at Cullimore and Ring Technologies. 303/971-0292. Or contact Ed Kroliczek at Swales and Associates. 301/902-4395. Please mention you read about it in *Innovation.*

Applications Vary for Mars Technology

LIQUID CRYSTAL TUNABLE FILTERS (LCTF) being developed for use in a future Mars mission rover are being used in a variety of research and low-cost commercial applications. This is being accomplished with Small Business Innovation Research (SBIR) program support from NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California.

Made by Cambridge Research and Instruments (CRI), the LCTF technology is used as optical filters that can be quickly tuned, electronically in a matter of milliseconds, to determine the best frequency and to select the best wavelength for imaging. The LCTF allows only specific colors of visible or infrared light to pass through to a camera lens.

A detailed and clear image is made by combining the available images using multispectral imaging techniques. With its optical properties, the liquid crystal is sandwiched between two sheets of material, usually a glass plate or other transparent material. The tunable filter is able to tune to the proper pass or reject frequency, thus allowing the selection of the best wavelength for imaging.

The medical imaging field has the most important commercial applications thus far. The LCTF is used in front of a microscope lens to quickly generate green, blue and red images, which are captured digitally using a monochromatic Charge Coupled Device (CCD) camera. These images, brought together, provide a clear color picture. Using a black and white (monochromatic) CCD camera for color pictures is important because it provides three times the spatial resolution of its color counterpart and is lower in cost.

Because there are no moving parts or changing of lens filters, the registration of the images is exact, with no blurring of the image. The picture requires no further processing and is readily saved or transmitted to another location.

Things not visible to the human eye can often be imaged using the LCTF and multispectral techniques. Separate images are prepared at different parts of the visible or infrared spectrum, and the images of their differences and contrasts are combined to prepare a new image. For example, a fingerprint may be difficult to see because of underlying printed material. Dyes highlight the fingerprint. Images are captured at parts of the spectrum where the dye is, and is not, visible. An image developed on the basis of the difference in images suppresses the writing and reveals the fingerprint. The Internal Revenue Service uses similar LCTF-based techniques to detect forgeries and altered documents.

Quick-tuning filters with important commercial applications are being used on a future rover, called FIDO, to determine minerals on Mars.

JPL illustrated the power of multispectral imaging techniques using an LCTF when legible images of the Dead Sea Scrolls were obtained. Little contrast existed between the ancient papyrus and the ink, making it unreadable to the unaided eye. However, in the spectrum's near-infrared band, the parchment becomes more reflective while the carbon-based ink remains dark. An LCTF made it possible to quickly scan the spectrum for the best imaging frequency.

JPL is using the LCTF on the Field Integrated Design and Operations (FIDO) rover, a demonstration platform for next-generation technology for Mars exploration. The filter is placed in front of a panoramic camera on the rover, allowing it to prepare images in three distinct wavelengths. The images enable scientists to determine the type of minerals surrounding the rover. This information is used for target selection and navigation purposes.

For more information, contact Patricia McGuire at the Jet Propulsion Laboratory.
818/354-1258, 818/354-2385, *Patricia.A.McGuire@jpl.nasa.gov*
Please mention you read about it in *Innovation.*

New Commercialization Initiative at Glenn

A NEW INITIATIVE OFFERS A COMPETITIVE advantage to small, disadvantaged, minority-owned or women-owned businesses in the Great Lakes Region through enhanced use of NASA programs, technology and expertise. The Garrett Morgan Commercialization Initiative (GMCI) provides access to NASA programs, technology and expertise while providing resources and services to successfully leverage technology in developing new products and processes or improving current ones.

NASA's Glenn Research Center and the Great Lakes Industrial Technology Center (GLITeC), one of NASA's six Regional Technology Transfer Centers, have teamed to help small businesses increase competitiveness. This effort will also assist the commercial potential of NASA Small Business Innovation Research (SBIR) technologies in the six-state area of Ohio, Illinois, Indiana, Michigan, Minnesota and Wisconsin.

The initiative was named in honor of the African-American inventor and entrepreneur, Garrett Morgan. Morgan founded a sewing equipment repair shop and invented a line of popular hair care products. His most well-known inventions, the automatic traffic signal and the gas mask, have saved countless lives.

Opportunities to grow a business by working with NASA abound, but accessing and making the most of them are not easy for companies operating on tight margins. With this in mind, GMCI services have been designed so companies can quickly identify promising opportunities and obtain the support they need to build opportunities into better bottom lines.

GMCI provides qualified companies with comprehensive business assessments, the identification of promising NASA opportunities, strategic planning, links to resources, partnership and project facilitation, and market development assistance.

For more information, contact Gynelle Steele at Glenn Research Center. 216/433-8258. Or contact Gail Wright at the Great Lakes Industrial Technology Center. 440/686-2208. Please mention you read about it in *Innovation.*

A new commercialization initiative honors inventor and entrepreneur Garrett Morgan.

FIELD CENTER NAME CHANGE CELEBRATED

The name of NASA's Lewis Research Center in Cleveland, Ohio, was officially changed to John H. Glenn Research Center at Lewis Field, following a ceremony in May. "The blending of names reflects the pioneering research in aerospace technology that employees have performed throughout the center's history, and will continue to perform in the future," said Center Director Donald J. Campbell. The research facility, built in 1941, was named for George William Lewis, research director for the National Advisory Committee for Aeronautics.

Glenn, a native of Ohio and the first American to orbit Earth in 1962, trained at Lewis as one of the original seven Mercury astronauts. In 1998, after serving four terms as a U.S. Senator, Glenn again made history as the oldest astronaut to fly in space as a crew member on the STS-95 mission.

John and Annie Glenn ride a Space Shuttle float during the official center name change festivities.

The Glenn Research Center is one of 10 NASA centers located across the country. The research and technology development work conducted at the center focuses on aeronautical propulsion, space propulsion, space power, satellite communications and microgravity sciences in combustion and fluid physics. More than 2,100 civil service employees and 1,500 onsite support-service contractors carry out its work. The center consists of 24 major facilities and more than 500 specialized research facilities at the 350-acre Cleveland site, next to Cleveland Hopkins International Airport, as well as the 6,400-acre Plum Brook Station in Sandusky, Ohio.

For more information, contact Laurel Stauber at Glenn Research Center. 216/433-2820, 216/433-2555, *Stauber@grc.nasa.gov* Please mention you read about it in *Innovation.*

TECHNOLOGY OPPORTUNITY SHOWCASE

Moving Forward

Technology Opportunity Showcase *highlights some unique technologies that NASA has developed and which we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in* Innovation.

Fixture for Stripping Coatings From Optical Fibers

Goddard Space Flight Center seeks licensing of its patented fixture for chemically stripping coatings from optical fibers in component assembly procedures. Unlike mechanical stripping, chemical stripping does not rely on using blades that may nick or scratch glass fiber, thus resulting in fiber breakage or a latent component defect. Goddard's fixture helps minimize the exposure of fiber components to chemical solution fumes, in contrast to simple immersion techniques. The fixture is nonreactive with most hot and cold chemical stripping solutions. Designed and used for NASA-qualified optical cable and buffered fiber, the device consists of a fixture body and handle (optional). A cable or buffered fiber is inserted through the device handle and fixture body, after outermost components are cut to the proper length. The cable or fiber is then firmly seated in the fixture body and the handle attached. Once properly seated, the coated fiber protrudes by the correct amount and is ready for chemical stripping. The fixture body and protruding coated fiber are immersed in a stripping solution up to a notch on the fixture tip. After about 90 seconds, common coatings (acrylate) soften and swell. The fixture and fiber are then withdrawn from the solution and the handle removed. A softened and swelled coating can be removed by sliding the fixture body off the fiber, or the coating can be wiped off with a cloth. The device can be used for most applications in which repeatability, dependability, or reliability is important or critical, including optical fiber connectorization, termination, splicing, or active device assembly (such as pigtailed lasers).

For more information, contact Joe Famiglietti at Goddard Space Flight Center. 301/286-2642, 301/286-0301, *Joe.Famiglietti@gsfc.nasa.gov* Please mention you read about it in *Innovation.*

Myrinet Fiber-Optic Extender

The Jet Propulsion Laboratory (JPL) seeks to transfer the Myrinet fiber-optic extender methodology to commercial users. Currently, it is used in such NASA applications as special effects rendering, computer-aided engineering, graphic design, architecture, medicine, geology and space science. The extender, aided by JPL's optical hardware base, provides a high-performance, scalable optical interconnection network (optical channel interface, or OCI) for massively parallel supercomputers, high-performance workstations and multimedia peripherals. With the optical support, this technology seamlessly transports data flow and stream traffic with little global network management overhead. This is accomplished by integrating into one network the best of two technologies—the ultralow latency of distributed Myrinet asynchronous electronic crossbar switches and the rich transport topology provided by wavelength division multiplexed fiber optics and OCI. The extender is 10 times faster than a 100-millibit/second ethernet, enables distributed memory (random access memory, or RAM) applications for workstation groups and allows for diskless workstations with significantly less RAM. The optical channel interface hardware is specifically tailored to work with the Myrinet hardware developed by Myricom, located in Arcadia, California. Potential commercial users will need to work with JPL to significantly reduce the board size by developing custom integrated circuits to implement the optical channel interface hardware.

For more information on commercialization opportunities, contact Alice S. Wessen at the Jet Propulsion Laboratory. 818/354-4930, 818/393-4093, *alice.s.wessen@jpl.nasa.gov.* Please mention you read about it in *Innovation.*

Signal Analysis System

Stennis Space Center is seeking qualified companies for the further development and commercialization of a signal analysis process as a method to increase the response speed of existing sensor technologies. The current NASA use for the signal analysis process is in a smart hydrogen detection system. The system predicts the steady-state response of a signal and thus can increase the speed of any sensor that responds to a step input. This means that a faster response can be attained without developing a faster sensor, making the system a potential cost-effective alternative for existing sensors that are limited by slow response times. The system employs a signal-processing algorithm to determine, in near real time, the steady-state response of a normally slow sensor. A small microprocessor samples the hydrogen sensor's output at small, regular time intervals and dynamically predicts the sensor's response to a step change in temperature. The algorithm has been implemented using both C and BASIC programming languages and resides as firmware in Erasable Programming Read Only Memory (EPROM). Potential commercialization opportunities are in hydrogen detection systems and industrial applications, including personal safety medical-type electronic thermometers.

For more information, contact Staci C. Kramer at Stennis Space Center. 228/688-2751, 228/688-3935, *staci.kramer@ssc.nasa.gov* Please mention you read about it in *Innovation.*

NCTN DIRECTORY

Moving Forward

NASA Field Centers

Ames Research Center
Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

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Dryden Flight Research Center
Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

Eugene (Lee) Duke
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Glenn Research Center
Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High Temperature Materials Research, Microgravity Science and Technology and Instrumentation Control Systems.

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Goddard Space Flight Center
Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

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Jet Propulsion Laboratory
Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics, and Autonomous Systems.

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Johnson Space Center
Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations

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Kennedy Space Center
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Langley Research Center
Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

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Marshall Space Flight Center
Selected technological strengths are Materials, Manufacturing, Non-destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

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Stennis Space Center
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NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

Joseph C. Boeddeker
Ames Technology Commercialization Center
San Jose, CA
408/557-6789

Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS
228/688-3144

Wayne P. Zeman
Lewis Incubator for Technology
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Thomas G. Rainey
Florida/NASA Business Incubation Center
Titusville, FL
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Events

The ***Third Annual Computational Aeroacoustics (CAA) Workshop on Benchmark Problems*** will be held November 8–10, 1999, at the Ohio Aerospace Institute, Brook Park, Cleveland, Ohio. The workshop's objective is to promote the application of computational methods in aeroacoustics. For this workshop, the Scientific Committee has chosen fan noise as its theme. There are six categories of benchmark problems, four of which are related to fan noise. Workshop participants are requested to solve one or more problems in any problem category and submit numerical solutions for evaluation. Submissions are invited on the solutions of the test cases at *http://www.math.fsu.edu/~smith/caawbp99.html* In addition to the benchmark problems, the workshop will feature an Industrial Panel. Representatives from industry will discuss the relevance of CAA for industrial applications. NASA's Glenn Research Center is sponsoring this workshop. For workshop registration and lodging information, call Dennis L. Huff at Glenn at 216/433-3913, fax at 216/433-3918, or e-mail to *Dennis.L.Huff@lerc.nasa.gov*

The ***8th Annual Space Frontier Conference,*** one of the leading annual commercial space conferences, will be held September 23–26, 1999, at the Sheraton Gateway near Los Angeles International Airport. Join leaders of private space enterprise, government, finance and the media on topics ranging from commercial space marketplaces of today, such as reusable launch vehicles and the International Space Station, to potential markets of tomorrow, such as space-based solar power, the Moon, Mars and asteroid mining. For more attendance, presentation or exhibit information, visit *http://www.space-frontier.org* or *http://www.space-frontier.org/EVENTS/SFC8/* or e-mail at *conference@space-frontier.org*

A workshop titled ***Mars 2001: Integrated Science in Preparation for Sample Return and Human Exploration*** will be held October 2–4, 1999, in Houston, Texas. The Science Operations Working Group for 2001 will be facilitating this workshop. Through talks, exhibits and presentations, including all active and planned missions, the workshop is intended to increase awareness of the missions' goals and potential and to give the science community opportunity for input. Although a new mission will not emerge from this workshop, there are many opportunities for experimental procedures, interactions between experiments and operational sequencing to be geared toward scientific questions. For more information, call LeBecca Simmons at the Lunar Planetary Institute at 281/486-2158, fax at 281/486-2160, or e-mail to *simmons@lpi.jsc.nasa.gov* Or visit *http://cass.jsc.nasa.gov/meetings/marsmiss99/marsmiss99.1st.html*

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